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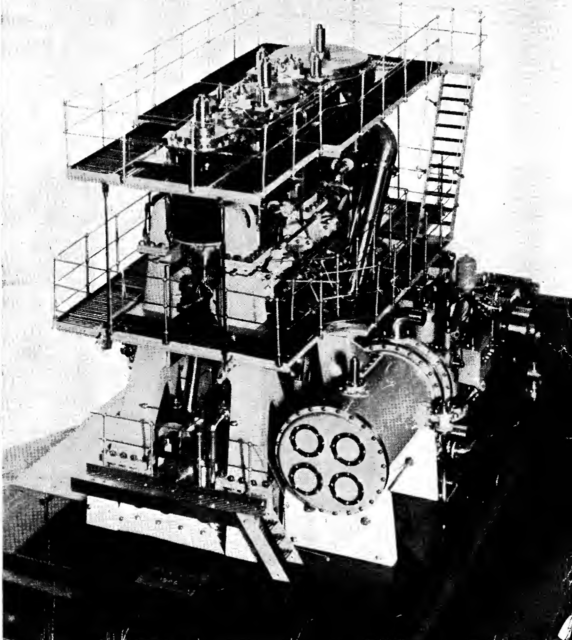

The MODEL ENGINEER

PERCIVAL MARSHALL & CO. LTD., 23, GREAT QUEEN ST., LONDON, W.C.2

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SMOKE RINGS

Our Cover Picture

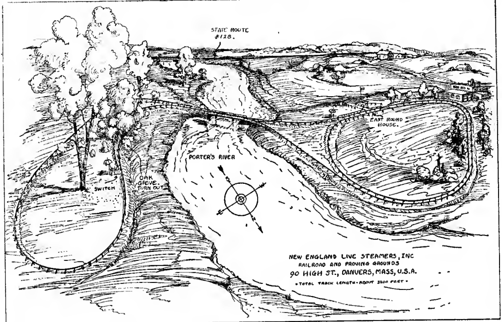
● THE FOURTH and last of a series of marine-engine models is depicted on our cover this week. All four are the work of Lieut. W. T. Barker, of the S.M.E.E., whose name, as well as the three previous models, will be familiar to older readers. A description of model No. 4, together with further photographs will shortly be published, for we have been privileged to examine the model closely and to obtain from its maker some interesting particulars of its construction.

Steam Engine Castings

● ONE OF the things that has impressed me in my recent correspondence has been the interest expressed in steam engines of all kinds. Many of my correspondents refer with pleasure to their early experiences in steam engine modelling, and in some cases this interest has remained unabated through the years. I realise, of course, that these reminiscences mostly date from a period before the arrival of the petrol engine, when an engine of any kind meant a steam engine, and no other castings or designs were available to distract attention. But the love of steam in some form or another still persists, and it is a matter for regret that castings for steam engines of various types are in such short supply. The steam locomotive is happily an exception, for builders of "live steam" engines are well catered for. To some extent this applies also to traction engines, but castings and designs for marine engines, mill engines, beam engines and other triumphs of the steam period are extremely difficult to come by. The model engineer whose inclination is in the direction of experimental work will find ample opportunity in the development of the petrol motor and the gas turbine and its application to speed boats, racing cars, and model planes. But there is another school of thought which seeks inspiration in the engineering achievements of the late Victorian era and has a quiet admiration for the design and varied constructive details and motion work of the old-time steam engine. The modern engine is largely of the enclosed type, its predecessors had all the motion exposed to the eye, and apart from the pleasure of making all the intricate parts, there was the permanent pleasure of being able to watch and study all those parts in active operation. The steam engine as a subject for modelling has by no means had its day, and I am convinced that there will long be a market for castings of engines of good and characteristic design. Some model makers are perforce reduced to making their own patterns and procuring their own castings as best they may. This is not a bad experience for them, and many of the models we illustrate bear evidence of much patient preliminary research and work of this kind. But recruits to the hobby who are steam engine minded find the market somewhat bare of castings and materials for their purpose and their immediate desires are thereby frustrated. The times are admittedly difficult, but I hope that when things become easier that we shall see a wider range of facilities offered for the steam enthusiast.

A Fine Track Layout in U.S.A.

● THE ACCOMPANYING sketch shows the track layout in preparation for the New England Live Steamers at Danvers, the home of Mr. Lester D. Friend. The track provides a continuous run of 3,200 ft. and, as will be seen from the picture, it is in very varied and attractive surroundings. Mr. Friend writes me :—" As to thing. Anyway, it's an excuse for 25 or 30 of us to drop in on them and bring along things which we are working on and also view the items which other Brothers are working on. We hold six of these cellar parties throughout the winter. You'd be surprised how it keeps up the morale and interest. Of course, the lady folk serve coffee and doughnuts which is also an enticing point."



our railroad facilities, Danvers is going to be still better off this year. We're continuing to grow. As you may know, the property that the N.E.L.S. uses belongs to my factory property and I lease it to the N.E.L.S. for one dollar per year. Of course, on top of that I guess it costs me about $500 a year personally to keep the place looking right. However, you can't take it with you so why not spend it? I thought you might like to use the panoramic view on my Christmas card in some future issue of THE MODEL ENGINEER. My designer drew this picture as a pen sketch from the top of another building close to us, so it is quite accurate and he has included all slight changes we contemplate to finish in the first six months of this year. As you know, 1948 is going to be the 16th Annual Brotherhood Meet which has really grown into quite a time. Carl Purinton being the president and secretary of the Brotherhood, usually invites everyone throughout the U.S. and three days is sometimes not enough for some of them. They usually come early and stay late and help us burn up our Welsh peacoal purchased some six years ago. As you may have gathered from my cards, etc., I'm quite an enthusiast and I believe in keeping contact with the Brothers right through the winter, so we hold what we call cellar gadfests. We've had three of them so far this winter. The first Saturday of each month we visit one of the Brothers who has just received a new lathe, drill or some-

A Model Engineer on Tour

● A NOTE from Mr. J. F. J. Stead, chief electrical artificer on *H.M.S. Birmingham*, tells me that his ship, now on the East Indies station, will be visiting a number of the principal ports in E. and S.E. Africa, Ceylon, and India. As an enthusiastic model engineer he would be pleased to meet brother model-makers who may be within reach at any port at which his ship calls. He has on board a 2½-in. gauge "Olympiade" ready for the road. So if the good ship *Birmingham* comes your way don't forget to extend a hand of welcome to Mr. Stead.

Landscape Gardening for Model Railways

● IN THE current members' letter of the West Riding Small Locomotive Society there is an appeal for those with expert gardening knowledge to take a hand in beautifying the surroundings of the splendid new track which is being laid down at Blackgates. There is a practical idea in this for other clubs, and for local authorities owning permanent passenger tracks in parks and elsewhere. I can see some future competition for the distinction of being the best laid-out and beautified miniature outdoor railway in the country. This applies to home garden railways—why not?

Percival Marshall

Something Rather Bigger

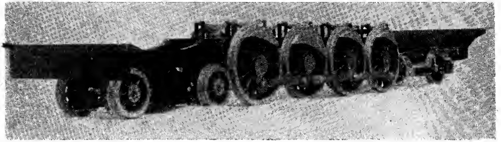
by D. A. Whiteside

I SUPPOSE my model making must have started when I was a boy, because I was always making cars from matchboxes, bits of cardboard, celluloid and cotton-wool. Strangely enough, I cannot recollect ever wanting to become an engine-driver. At the age of 14, I was car mad. I haunted Olympia every year and the local car showrooms almost every day, and my first serious effort was a 1-in. scale model of a Stutz Roadster built in the school manual centre; I was then 16. My passion for modelling lapsed when I went out to work, and it was not until 1938 that I started again, this time with a Hobbies lathe and a collection of odds and ends in the hand-tool line. I made aircraft almost by the dozen, miniature articles of furniture, models of boats and guns; but—nothing worked! Then, in 1941, came my opportunity. I was offered a brand-new 3½-in. lathe which somehow I managed to afford. This was quickly rigged up in the spare room and a second-hand motor, four-jaw chuck and a few tools bought. I began with simple articles such as tap wrenches, die stocks, tool-makers' clamps and so on, until I realised that now was the time to build a real model.

I commenced building a "Molly" 0-6-0 tank locomotive. That the Stephenson's link motion fitted to this locomotive was a real "box of tricks" didn't worry me at all, thanks to "L.B.S.C." That a complete novice can build a successful locomotive, given the correct instructions, was amply demonstrated when, in 1943, on her first real run out, she walked away with six full-sized men and a boy without slip or fuss. That from a locomotive weighing less than 40 lb. empty is, to my mind, nothing short of amazing.

My thoughts then turned to something rather bigger, something which would not need attention all the time for firing and watering.

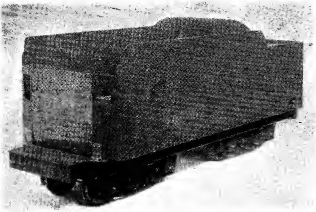
Looking through some back numbers of the "M.E." one evening, I came across a photograph of a 4-8-2 locomotive built by The North British Locomotive Co. for South Africa. Now the South African gauge, as we all know, is 3 ft. 6 in. and that means 1-in. scale for 3½-in. gauge. So to build a locomotive of this type is to build one which can be run on the most popular gauge and yet without making the parts unnecessarily heavy can still keep within range of the 3½-in. lathe owner, yet will produce a job which will dwarf any normal 3½-in. gauge locomotive. This was the job for me, I decided; and so I got to work. I approached the N.B.L. Co., and R. Stephenson & Hawthorn, in turn, for drawings but without success; so in desperation I wrote to the South African Government in Trafalgar Square. Not only did they have all the original drawings of the class I had chosen, namely the "15F," but they invited me to visit them, examine the drawings and select those which I required, from which they would have prints made for me. Consequently, I spent a whole Saturday morning there in a locomotive paradise, and, the following Tuesday, collected a huge parcel of 44 drawings which I had selected as the basis for my design. Now I am by trade an engineering draughtsman, so the formidable task of sorting the wheat from the chaff, of knowing where to stick to the design and where to break away, came easily to me. I did decide, however, that I would not work partly from ideas and partly from rough sketches, but would spend a little more time on the job and prepare a set of fully-detailed drawings which I could work from without having to resort to trial-and-error; and this has paid dividends over and over again.



No. 1.—The chassis of "15F" South African locomotive, 3½-in. gauge

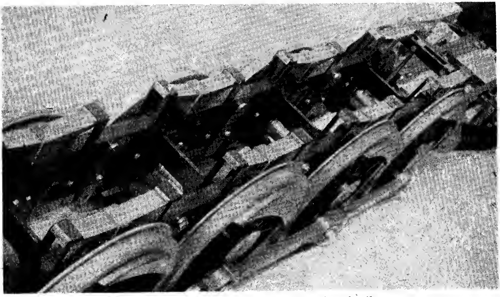
A word or two about the locomotive here will not be amiss. She is a 4-8-2 tender locomotive with two cylinders 1⅜-in. bore × 2¼-in. stroke. The valve-gear is Walschaerts, driving ⅞-in. dia. piston-valves which have a ⅝-in. travel and 80 per cent. cut-off in full gear. The frames are of the conventional Colonial bar-pattern 2¼-in. wide × ⅜-in. thick; but they are bossed up to ⅝-in. thick round the axlebox openings, reduced to ¼-in. thick over the trailing truck and are of a complex shape.

Now I like hard work but I just could not face these frames in mild-steel. Possibly, three months' work with hacksaw, drill and file did not appeal to my uncalloused hands; so I decided



No. 2.—The tender

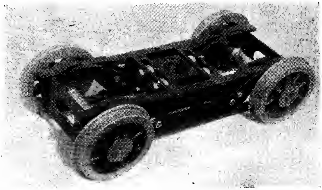
and bottom edges were filed up true and straight, then the centre-lines of the axles were marked out. All other dimensions were based on these centres, and the job was filed up to length; the various heights were checked from the bottom of the frame, using this as a datum. The reduced ends of the frames were fly-cut on a small bench mill and I can certainly recommend this where the job is rather too large for the lathe. The holes for the spring equalising rockers were next drilled and spot faced on the inside. The six distance-bolts were made, which allowed the frames to be bolted together in correct alignment and the right distance apart.



No. 3.—Photo showing main suspension details

to try an experiment. I had a pattern made, and the frames were cast in gun-metal. Bridges were left across the axlebox openings to avoid distortion when the frames were drawn from the mould, and they were a beautiful piece of work. Although 3 ft. 6 in. long, they were dead straight and true, there was no trace of wind anywhere. The shrinkage allowance had to be carefully watched on a job of this sort, and I give full marks to the pattern-maker who achieved almost " spot-on " accuracy in all dimensions.

Machining the frames was a comparatively easy task. The top



No. 4.—The leading bogie

The job was then put on one side and the hornstays were taken in hand. Obviously, with gunmetal frames having a considerably reduced section above the axleboxes, plain hornstays would have been useless, as the thrust from the driving boxes would have probably sheared the bolts. Consequently, the hornstays were checked to the frame as can be seen in photograph No. 3. The hornstays were then fitted carefully to the frames and the bridges cut away so as to ensure that the frames did not spring. After this, the axlebox openings were machined by using a reamer as an end-mill in the milling-machine and traversing the job down, along, and up again.

The driving and coupled wheels and axles were plain turning jobs, but it will be noticed that the driving-wheel balance-weight is very much deeper than those on the coupled wheels. I did not wish to spend too much on patterns and, in any case, considered it rather a lot of metal to cast, so, using coupled wheels, I built up the balance-weight by plating back and front with 1/32-in. gauge plate and then filled up with " Cerro-Matrix. This works very well and looks quite the part.

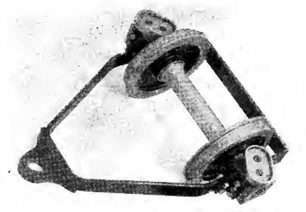
The main axleboxes are split and have keeps retained by one taper pin. The shape of the boxes is such that a projection at the top carries a pedestal on which the spring-buckles bear. The rubbing-faces of the boxes, however, are covered with 1/32-in. plate so that dissimilar metals are in contact with each other. Positive lubrication is provided to the axle journals and the rubbing-faces of the boxes as well, so wear should be at a minimum.

The coupling-rods do not require any special comment except for their size. They are, of course, very massive which is in keeping with the rest of the job. Phosphor-bronze bushes are fitted, all running on silver-steel crank-pins, the driving-pin of which is $\frac{5}{8}$ in. dia. and the remainder $\frac{7}{16}$ in. dia.

The leading bogie was soon complete and, as can be seen from photograph No. 4, it is sprung with working leaf-springs and has double equalisers inside and outside the frames. The king-pin block is suspended on swing-links, which, contrary to what seems usual practice, are parallel. Here I must admit I am blindly following the prototype and propose to watch what happens when the locomotive takes the road. Side control springs are omitted, as in the prototype ; and here, again, results will be carefully watched.

The trailing truck is of conventional pattern and requires no comment except to note that the oval pans to take the spring-buckle slides in the fully equalised springing arrangement, are clearly shown in photograph No. 5.

The real interest of this job lies in the springing which, reference to photographs Nos. 1 and 3 will show, is so arranged that compensation is taken right through from the leading coupled wheels to the trailing truck. The photographs show clearly how this is done, and suffice it to say that it really does work. All leaf-springs are built up from 26-s.w.g. spring - steel of varying widths ; but, in the case of the main springs, some of the leaves are cut out in the centre to reduce their strength. The estimated loading is from 14 - 16 lb. per spring and the deflection about $\frac{1}{8}$ in.



No. 5.—The trailing truck

The tender, photograph No. 2, is an eight-wheel bogie job, the frame of which is built up from four 1-in. $\times$ $\frac{3}{8}$-in. $\times$ $\frac{1}{16}$-in. channels covered with a soleplate. The bogies are fully sprung with leaf-springs and, like the leading bogies, have double equalisers. A different form of construction was used for these bogies, however, to cut out much laborious work. Instead of cutting the frames from the solid as in the leading bogie, they were built up from strips of material, and the hornchecks were made in cast-iron bolted in place. The side frames are held apart by a master frame $\frac{1}{4}$-in. thick, to which are attached phosphor-bronze rubbing-pads engaging steel bolsters fitted to the underside of the channel frames. In this way the load is completely taken off the king-pins except for direct side thrusts. The tank is all brass and, when photographed, was not by any means complete. It measures exactly 24-in. long $\times$ 10 in. wide $\times$ $7\frac{1}{2}$ in. high at the deepest part, so will hold a very large amount of coal and water.

A few notes about the rest of the job will serve to illustrate the complete locomotive. It will be fitted with working steam brakes, and the tender with vacuum brakes. The valve-gear will be steam-reversed, and there will be a four stage poppet type front end throttle in the smokebox. The boiler will have twenty-six $\frac{1}{2}$-in. flues and four $\frac{13}{16}$-in. superheater flues, combustion chamber and live-steam fittings. It will be fed by two injectors under the cab, and the only other pump will be a double-acting twin-barrel hand-pump of my own design in the tender. Lubrication to the cylinders will be by mechanical lubricator with double plunger, as described by " L.B.S.C." for " Hielan' Lassie." Cylinder drain-cocks and sanding-gear will also be fitted.

An Electric Bed-Warmer

Being instructions for making an "electric blanket" and also a useful ohmeter from Government surplus material—by H.C.W.

MODEL engineering is nothing if not versatile and the successful model engineer should be able to apply his experience to solve the many problems, not necessarily associated with the making of models.

The writer had for some time considered the discomfort of having to get into cold sheets in the depths of winter and the drawbacks of the hot-water bottle as a palliative for this state of affairs, and finally decided that it was about time something was done about it.

It seemed fairly obvious that some form of electric heating would be the ideal solution, and yet the idea of enclosing a 40-watt bulb in a cocoa tin and using it as a hot-water bottle seemed to suffer the same disadvantages as the latter in that one's feet might be uncomfortably hot and yet one's back might be frozen.

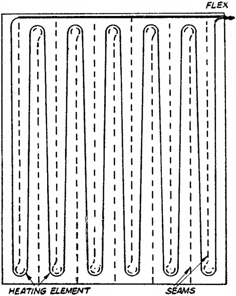


Fig. 1

First Experiment

To be successful, electric heating should be applied over a much larger area, and so the construction of an electric blanket was the first experiment to be undertaken in this field. A rough estimation showed that about 40 watts would be required to get the bed comfortably warm in, say, two hours. This meant that, for a 240-volt circuit, the heating element wire would need to have a resistance of about 1,450 ohms. It was proposed to wind this wire up and down the surface of half a blanket, zig-zag fashion, with about 4-in. spacing.

Now, since the blanket was liable to be pulled about to some extent in making the bed, the wires should not be so thick as to lack flexibility, and yet they should not be so thin that they would easily break. A good all-round compromise was made and a length of resistance wire was duly sown into the blanket, which was about 3 ft. × 4 ft. The wire was double silk covered and the connections to the ends were carefully insulated. For a while all worked very well. The bed got comfortably warm in about $1\frac{1}{2}$ hours and seemed to reach its maximum temperature in that time, also, if the element was left on for several hours, the wire did not get nearly hot enough to discolour the silk insulation.

Troubles Appear

Two main difficulties now emerged. The first was that the thing in itself was too heavy. It was

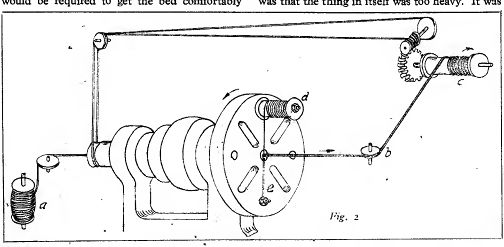


Fig. 2

additional to the normal bedclothes and, unless one blanket was removed to make way for it, the bed became uncomfortably hot later in the night, necessitating throwing the eiderdown on to the floor as a corrective. Since an eiderdown appears to be worth at least two blankets, from a heat insulation point of view, the bed soon became too cold and the night was apt to be spent in adjustment between the two extremes of temperature, to the detriment of any rest which might otherwise have been obtained. If, however, the electric blanket was used in place of a normal, full-sized blanket, it didn't cover the whole bed, and left the outer edges insufficiently covered. The other disadvantage was that the wire was very liable to break.

An Electric Sheet

To overcome these troubles, therefore, the element would have to be sewn into some lighter material which would not, in itself, add to the weight of the bedclothes, and also some means must be found of adding strength to the wire. For the next experiment, therefore, a sheet was used, folded in half and sewn in sections as shown in Fig. 1, through which the element was threaded. The wire, to give it increased strength, was to be wound on stout thread so that it would be relieved of practically all mechanical stress.

Since this latter job seemed to be well-nigh impossible to do in any other way, it was carried out in the lathe. The general set-up will be seen in Fig. 2. The thread was drawn through the headstock mandrel from a bobbin (*a*) running on a spindle held in the vice and suitably tensioned with a spring, taken round a pulley (*b*) fixed to the cross-slide, and wound on a drum (*c*) mounted behind the lathe and driven by a wormwheel and string belt, not to mention several other pulleys, from the headstock. Most of the fitments used were obtained on loan from the junior mechanic's Meccano box. On the faceplate was fitted a bobbin of resistance wire (*d*) on the one side and a wire guide (*e*) to hold the thread steady on the other (see details in Fig. 6). It was necessary to have the tension on the resistance wire bobbin sufficient to ensure that the wire was wound on the thread securely and not loosely, and to have sufficient tension of the spool of thread to prevent the latter twisting in the winding process. Once this process has been set up correctly, it works very well and will continue winding until the thread or the wire gives out. The pitch of the winding is decided by the reduction ratio of the drive to the drum (*c*) from the headstock. It should be about three times the diameter of the wire itself. The thread should be about ten times the diameter of the wire.

A Few Technical Details

Before going any further it would perhaps be advisable to cover, as briefly as possible, a little elementary electrical theory for the benefit of the purely mechanical engineer who doesn't know any. Electricians can skip this part.

It is first necessary to have a clear conception of three units used in electrical work. The first is voltage, which we will call V and is analogous to pressure or the head of water in a pipe line. The next is current, measured in amperes, which we shall call C. It is the flow. The third is resistance, R, measured in ohms, of any circuit through which the current C is made to flow by the pressure of V volts.

It should be clear that every wire will have resistance and that the longer and thinner the wire, the greater will the resistance be, and, conversely, the shorter and fatter the wire, the less will the resistance be. Also the resistance of metals varies from one to another ; for instance, an iron wire will have about six times the resistance of a copper wire of the same size, whilst one of German silver will be about twenty times as great as copper. Most metals vary their resistance with change of temperature, but some alloys, such as Constantan, do not do so appreciably. These alloys are used in instruments where an accurate and invariable resistance is necessary.

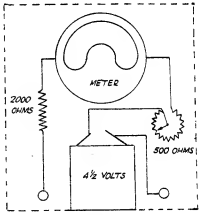


Fig. 3

The relationship between our three units is usually stated as :—

$$C = \frac{V}{R}$$

and is known as Ohm's Law.

It means that the current in any circuit will vary directly as the voltage is altered if the resistance remains the same, and also that it will vary inversely as the resistance if the voltage is maintained constant.

An Ohmeter

It is extremely handy to have available in the workshop an instrument which can be used to measure resistance, called an ohmeter. It consists of a fairly sensitive d.c. meter with a dry battery of, say, 4½ volts, and two resistances, all of which should be connected in series and fitted in a box with two terminals on the front. The meter should be of the moving coil type and should have a full-scale reading of 5 milliamps or less (that is 0.005 amp.). Such meters are available from the ex-Government stores for a few shillings at the present time.

Let us suppose, for example, that a meter reading 2 ma. (milliamps) has been selected. It

should be clear from Ohm's Law that, if this meter is connected in series with resistances totalling 2,250 ohms and a $4\frac{1}{2}$-volt battery, the current will be 2 ma. and the meter will then read full scale, i.e. 2 ma. The value of the resistances should, in practice, be slightly less than 2,250 ohms to the extent of the resistance of the meter itself. To achieve this we use a fixed resistance of, say, 2,000 ohms, and a variable one of, say, 500 ohms, which also enables an adjustment to be made for small changes in the battery voltage. (See Fig. 3.) The variable resistance is adjusted so that the meter reads full scale when the terminals of the instrument are connected directly together; that is, when no external resistance is in circuit. This brings the needle to a point on the scale and we mark O ohms to correspond with this point of 2 ma.

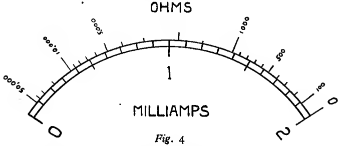


Fig. 4

It should be clear now that, if we connect another resistance, external to the box, in the circuit, which has a value of 2,250 ohms, the total resistance would be doubled, causing the current flow to be halved, and the meter would read 1 ma. This would give us another point on the scale corresponding to 2,250 ohms. This isn't a very suitable figure for our scale and it would be better to mark it in round numbers, like 2,000 ohms and 3,000 ohms, but it is useful to remember that the half-scale calibration of such an ohmeter indicates the value of its internal resistance.

To do the actual calibration, we should take the 100-ohm point first. Now, if 100 ohms is connected externally, the total resistance will be 2,250 + 100, and the current will therefore be $\frac{4.5}{2,350} = 1.92$ ma., and we mark 100 ohms at 1.92 ma. on the scale. Similarly, 200 ohms will be $\frac{4.5}{2,450} = 1.84$ ma., and 1,000 ohms will be $\frac{4.5}{3,250} = 1.38$ ma. All the main readings should be worked out in this way. The completed scale will be as shown in Fig. 4.

Final Details

And now to get back to our bedwarmer; we need a length to give something like 1,500 ohms of our wire-wound thread. That made by the writer was approximately 30 ohms per foot, giving 50 ft. of element to be disposed as shown in Fig. 1. The wire was 40 s.w.g., uninsulated. Any kind of resistance wire can be used provided it can be wound conveniently into about 30 ohms per foot. The bare element wire can be bound to the flex connections at the ends with the same kind of wire and the connections should then be taped up. Care must be taken that different parts of the element cannot come into contact with one another and the ends should be at opposite sides of the sheet.

The flex connection should be firmly anchored to the sheet by sewing, so that a tug on the flex will not put any stress on the element. It is also a good idea to fit a small tell-tale lamp in series with one of the mains leads to show when current is flowing. A small torch bulb is quite suitable but it should be mounted in some kind of bakelite fitting which will completely shroud any metal parts which are connected to the circuit. See Fig. 5.

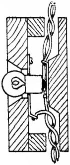


Fig. 5. Tell-tale lamp-holder

Make sure that all connections are taped up properly and that no loose ends of element wire are sticking out anywhere where they can project through the bedding and come into contact with the occupant. The results would be very unpleasant, to say the least of it. Place the electric sheet on top of the first blanket but under the second or any eiderdown. Do not sleep on top of it. Treat it with care and switch off when getting into bed.

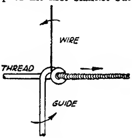


Fig. 6. Details of winding guide

For local heating the writer also made an electric pad from part of a pair of Home Guard trousers sewn up in sections, as shown in Fig. 1, but only 12 in. × 15 in. This was wound with element wire of 47 s.w.g. wound on thread of a resistance of 180 ohms per foot. Its total resistance is 3,500 ohms and the power taken is therefore 16 watts. This is put in an outer linen cover and is much more robust than the large sheet and may be used in any position.

IN THE WORKSHOP

by "Duplex"

3—Milling Operations in the Lathe

MILLING operations in the lathe have from time to time been fully and lucidly described in THE MODEL ENGINEER, and it is now the intention to refer here, in particular, to examples of the subject that require only simple equipment, and so make a special appeal to the small workshop user and the amateur with limited resources.

Types of Milling Cutters

At the outset it should be stressed that the less massive type of lathe, which best serves the diverse requirements of the small workshop, is not usually well-suited for taking even moderately heavy cuts with multiple-tooth milling cutters. During an ordinary turning operation the thrust exerted by the tool and its reaction on the lathe mandrel and its bearings are even and continuous, as is shown by the long shavings produced and the smoothness of the turned surface. In the case of the multi-tooth cutter, on the other hand, the cutting pressure is intermittent and tends to cause vibration, as evidenced by the small chips produced and the irregular surface of the finished work, where the machine is not sufficiently rigid to withstand the stresses imposed.

Examination of a commercial milling-machine will at once show that rigidity is regarded as of paramount importance, for the spindle and its bearings are of massive construction, as compared with similar parts in the light lathe, and, in addition, the milling arbor is given adequate support where required to ensure rigidity.

Again, the commercial type of milling cutters, particularly those made of high-speed steel, are very expensive, and, if good work is to be expected, frequent re-sharpening will be required, which is also an expensive item, as special equipment, not usually found in the small workshop, must be used for this purpose.

However, the case is very different when a tool with a *single* cutting edge is used, for the milling operation then amounts to little more than turning in reverse; that is to say, the work is held stationary and the cutter in the form of a lathe tool revolves. If the work is rigidly supported, there will be little tendency to vibration, the chip forms a more continuous shaving, and the surface of the work will have a high finish equal to that produced by turning.

As to the cutters required, these can well be the short lengths of heat-treated high-speed steel that are commonly used in lathe tool-holders; moreover, these tools can readily be ground to any form required, and, as a really sharp cutting edge can be easily maintained, an excellent finish is given to the work.

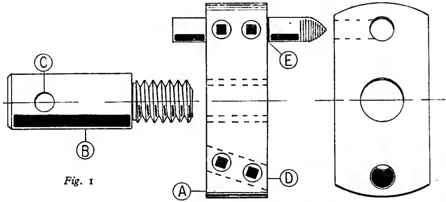


Fig. 1

The operation in which a revolving tool with a single edge is used in this way is termed fly-cutting; and, although the process is not comparable with commercial milling for the speedy removal of metal, it will probably do this up to the capacity of the light lathe, and a good deal quicker than would be possible with a multi-tooth cutter in similar circumstances, for, to avoid vibration, it will be found that cutters of the latter type have to be run comparatively slowly, whereas the fly-cutter operates well at normal lathe turning speeds.

A further advantage of the fly-cutter is that it can readily be shaped for cutting any desired profile such as pinion teeth, keyways, and reamer or tap flutes, whilst, on the other hand, when a multi-tooth mill is used a more elaborate and probably expensive cutter will be required for each operation.

Fly-cutters

When facing work attached to the lathe saddle, the fly-cutter can be conveniently mounted

in a holder which, in turn, is held in the self-centring chuck.

In Fig. 1 a holder is shown that is suitable for carrying out facing operations, and also for undercutting the work up to a shoulder if required. As will be seen, the cutter-head (A) is screwed on to a shouldered shank (B), and the latter is provided with a tommy-hole (C) to facilitate dissembly. Two stations for ¼-in. diameter round tools are provided: that at (D) is drilled at an angle to allow the tool to cut against an overhanging shoulder, and the position (E) is used for facing operations in general.

The tools are clamped in place preferably by sunk Allen screws, as whenever possible projections such as bolt- and screw-heads should be avoided on the revolving parts of machines, for disregard of this precaution may result in a sleeve or cleaning rag being caught up, with serious consequences to the operator. The tail of the tool, which projects backwards, should engage one of the chuck jaws to prevent rotation of the shank when clamped in the chuck. Where it is important to minimise overhang of the tool and thus increase rigidity, the shank of the holder may be held in either a collet chuck or an adaptor made to fit the lathe mandrel nose.

When large areas have to be machined, the radius of action of the cutter may be increased by removing the cutter-head from its shank, and bolting it to the lathe driver-plate or face-plate; as before, the tail of the tool should engage the slot of the faceplate to prevent displacement, and, in addition it may be possible to pass a second clamping bolt through the tool housing as a further means of security. The tools used for facing should have a slightly rounded point to give a smooth finish to the work, and the top rake should be suitable for the material machined, varying from 25 deg. in the case of aluminium alloys to 15 to 20 deg. for cast-iron and mild-steel, whilst for brass alloys 0 to 5 deg. will usually be found to give the best results.

In every case, if accurate machining and a good finish are sought, it is essential that the tool should have a really smooth sharp cutting edge; by this it is meant an edge which not only seems sharp to the finger, but one which will readily cut the skin if due care is not taken when manipulating the work.

Fly-cutting Keyways

This operation can usually be successfully carried out with a single-point cutter, and moreover, the tool edges can readily be made truly sharp, as opposed to a circular cutter which has been in use for some time, and is in need of re-sharpening. The fly-cutter should be mounted as illustrated in Fig. 2 and held in the four-jaw independent chuck. It will be seen that the shank of the holder is provided with a shoulder to give positive end location against the chuck jaws: an important consideration when the chuck setting has to be adjusted during the machining operation. The tool itself is housed in a cross-drilled hole and is held in place by an axial bolt, or preferably by a sunk Allen screw.

The tool-bit is formed like a parting tool with side clearance and a top rake suitable for the material machined, but additional front clearance may be necessary to ensure that the front face of the tool behind the cutting edge does not rub against the work. To use the device for cutting a keyway, the shank is gripped in the four-jaw chuck, as previously stated, and the tip of the tool when in a vertical position is brought into contact with the work, as shown in Fig. 3, either by adjusting the tool-bit in the holder or by altering the height of the work.

The work, which will usually be a round shaft, can generally be held in the lathe tool-post, with a suitable support arranged beneath to prevent the shaft springing away from the cutter; but if the work is too large for mounting in this way, a pair of V-blocks may be used, such as those supplied by Messrs. Myford for clamping work to the lathe saddle. A depth of cut can be put on the tool either to cut the keyway to its full depth at one passage of the cutter, or several cuts may be taken to complete the operation.

In the case of the latter method, successive trial cuts can be taken until measurement of the keyway shows that the required depth has been obtained. On the other hand, it is a simple matter to estimate and set the depth of cut by direct measurement. After the point of the tool has been adjusted to make rubbing contact with the shaft, the dial test indicator is mounted on the column of the surface-gauge, with the guide pins of the latter in contact with the front shear of the lathe bed. The contact point of the dial indicator is then brought to bear on the cutter point, as shown in Fig. 4, and the dial is set to the zero mark.

For the benefit of those who are not fully familiar with the use of the dial test indicator, it should at this point be explained that the standard makes of these instruments, such as those manufactured by Messrs. Starrett, and Browne & Sharpe, can be mounted on the pillar of the ordinary surface-gauge as depicted in Fig. 4.

In this way, both the coarse and fine adjusting mechanisms of the surface-gauge can be used to position the indicator in relation to the work. The coarse adjustment is made by slackening the pivot clamp finger-nut and then swinging the pillar, and the final fine setting by means of the screw indicated in the drawing.

Let us return to the setting of the fly-cutter, with the tool and the test indicator arranged as shown in Fig. 4.

Any desired cut, up to the full depth of the keyway, can now be put on the cutter by the simple expedient of adjusting the four-jaw chuck and reading off the amount of cut as shown by the dial indicator, which will register the additional distance the cutter has been set outwards from the lathe centre-line. It should be noted that the shank of the cutter is provided with a peg which, when in contact with the chuck jaw, will prevent any slipping that would upset this adjustment of the tool.

The foregoing references to the dial test indicator may have little interest for those who do not possess or do not intend to acquire such an instrument, but its use in this connection has been described, as it is so generally employed even in the small workshop, and in a future article it is hoped to deal with this subject more fully.

Nevertheless, there is no need for despondency on this score, as the deficiency can be made good by using the index of the lathe cross-slide in the following manner.

The cutting edge of the tool is set at the lathe centre height, as in Fig. 4, and a short length of brass bar is clamped to the lathe saddle to act as a setting stop.

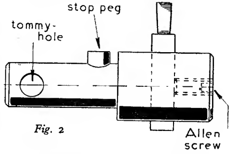


Fig. 2

The cross-slide is then fed inwards until the stop makes contact with the tool, and the cross-slide index is set to zero and locked in that position. To re-set the tool, the cross-slide is backed away and then fed forwards until the index registers the amount of feed required; that is to say, zero *less* the feed distance. The tool while still at centre height is then adjusted until it makes contact with the setting stop in its new position. The setting of both the stop and the index should be preserved throughout the machining opeiation, in case re-setting of the tool is needed.

When cutting keyways in the above manner, with the lathe turning in the normal direction and the work situated below the cutter, it will be found that the tool has a tendency to grab or climb and so carry the shaft forwards; this difficulty may be overcome by tightening the adjusting screws of the cross-slide gib, until firm pressure is required to operate the feed-screw, and, if available, the automatic cross-feed should be used in order to maintain an even feed movement.

Before citing a practical example of keyway cutting, it should be emphasised that a fly-cutter will cut a groove exactly equal in breadth to the width of the cutter, except, of course, for a very small working clearance, but the circular cutter will machine a keyway equal to the breadth of the widest tooth, plus twice the amount of any wobble that may be present. Furthermore, the point of the fly-cutter always traces a circular path, but if a toothed cutter runs out of circular truth, then all the work may fall on a single tooth and we are back to our old friend the fly-cutter but of a rather indifferent type.

It may be remembered that a few years ago THE MODEL ENGINEER drilling machine of ½ in. capacity was described in this journal. This machine was cleverly designed to enable the amateur to build an excellent high-speed drill with the aid of a 3½ in. lathe.

Although commercial small drilling machines of this type can be purchased, at a price, the design and workmanship of some would hardly satisfy the more fastidious workers who are accustomed to a high degree of hand finish, and, as castings to make THE MODEL ENGINEER machine are apparently still available, some, no doubt, will prefer to build for themselves.

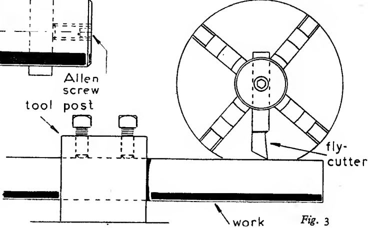


Fig. 3

In the construction of this machine, the drive pulley carries a key which slides in a keyway cut in the drill spindle, and to ensure satisfactory operation these keyways should be properly cut and the key accurately fitted.

In the example of the machine made by the writer, this work was so easily and successfully carried out that it may be cited to show the possibilities of fly-cutting.

After a piece of ground tool-steel had been selected for making the key, its thickness was measured with the micrometer, and a tool was made of this width similar to that shown in Fig. 2. This tool was mounted and set to the work as already described, and, with the aid of the dial test indicator, the fly-cutter was adjusted to form the keyway in the alloy steel spindle at a single cut, with the cross-slide self-acting in operation. The tool was then removed and its width was reduced by one-thousandth of an inch on an oil stone, after which it was mounted in a small boring bar held in the lathe tool-post, and the internal keyway was cut in the drive pulley, gripped in the chuck, by a shaping process, which it is hoped to describe in a future article.

The outcome of these machining operations was that a keyway was formed in the spindle with a highly finished surface, which allowed the key to slide smoothly and without shake, and, at the same time, the key was a firm press fit in the pulley; moreover, after several years' use, the key still appears to be a perfectly smooth sliding fit.

Woodruffe Keys

These keys of approximately semi-circular disc form are now much used, as accurately fitting keyways can be readily machined by means of toothed cutters of standard width and diameter. As these cutters are expensive and are rather easily broken in the small sizes, it may be found more satisfactory to use a fly-

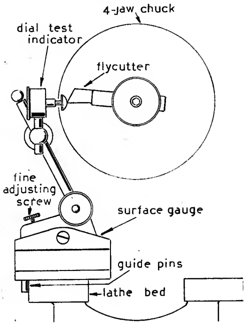


Fig. 4

cutter for this work where time is not of great importance. In this case, the shaft is fed directly towards the cutter in order to form the curved key recess. If the shaft can be mounted vertically, it may be fed to the cutter by means of the lathe cross-slide, but, if mounted horizontally, an elevating or vertical slide attached to the lathe saddle will be required. If a key of this type has to be fitted firmly into a shaft and at the same time be a sliding fit in another component, the same machining procedure can be followed as already described in the case of the drill spindle and its pulley.

If there is any lack of rigidity in the lathe headstock, for this and for other keyway cutting operations, additional support should be given to the tool by engaging the tailstock centre in a prepared centre recess drilled in the head of the tool-holder. In this case, the tool clamping screw must be fitted at the side of the holder, and not in its end as is illustrated in Fig. 2.

End-mills

The commercial pattern of end-mill usually has four or more cutting edges which are increased in number as the diameter of the cutter enlarges.

These tools suffer from the disadvantages previously mentioned, for not only are they expensive, but they are difficult to re-sharpen, and give very poor results when blunt.

Here, again, the simple form of end-mill with but two cutting lips is perhaps better suited to the small workshop, owing to the ease with which it can be made in any required size and resharpened by hand whenever necessary.

Fig. 5 illustrates what is, perhaps, the most useful form of these end-mills and the method of making them.

Broken twist drills can be made into end-mills by grinding the ends square and then grinding the cutting edges as in the previous example. Short lengths only should be used, as these drills have but little inherent rigidity, but their spiral form gives a cutting rake which is helpful when machining steel.

Although so far milling and fly-cutters have been described as attached to the lathe mandrel, some are equally well suited for use in a separately driven milling spindle mounted on the lathe saddle, whilst the work is held in the mandrel chuck, or is carried between the lathe centres. This latter method is often used for cutting small pinion teeth with a suitable form of profile fly-cutter, and, moreover, this arrangement

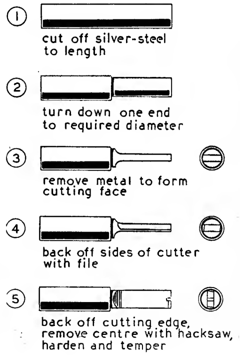


Fig. 5

allows the mandrel dividing gear to be used for indexing the teeth. On the other hand, greater rigidity is obtained when the milling cutter is mounted on the lathe mandrel, and, in addition, both the full driving power and speed range of the lathe are then available for operating the cutters.

Attaching Parts to Sheets

Referring to the subject of the correct use of screws for assembling components dealt with in Part 2 of this series, it may be opportune to consider the methods usually employed for attaching parts to metal sheet by means of screws.

In order to provide an adequate hold for the screws, a shouldered boss or bushing may be soldered or silver-soldered to the work as shown at (*A*), Fig. 6.

In the case of commercial sheet-metal work, it may be found that a hold for the screws is provided by using screwed bushes or seatings of the form, as shown at (*B*).

As in the previous instance, the small end of the bush is inserted in a hole drilled in the sheet, and the projecting part is closed on the work by means of a suitable punch or set. This secures the bush firmly in place, as depicted at (*C*), and no additional fixing with solder is required.

Alternatively, a quicker and cheaper method is sometimes used in the case of mass-produced articles; and although this may be found quite satisfactory for some purposes, it may not appeal to the more fastidious workers. A hole well below the size of the normal tapping hole is first drilled or punched through the sheet as at (*D*). This hole must not be too small, or the metal will tend to split when expanded as follows. As shown at (*E*), the sheet is placed on a metal block having a clearance hole, and a tapered punch, such as an ordinary centre-punch is driven into the work until the tapping size drill will just enter.

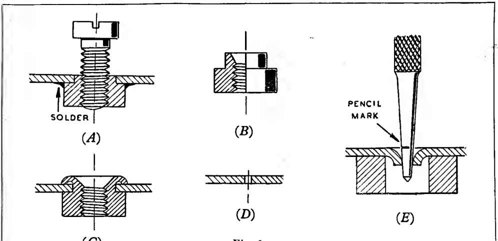


Fig. 6

The resulting tapered hole is then tapped in the usual way; and, should it be a little undersize, the tap will correct this as it passes through the work.

To save time, and for the sake of uniformity, when several holes have to be dealt with in this way, the centre-punch should be inserted in the tapping size hole in the drill gauge and the distance the punch enters is marked with a grease pencil. The punch can then be driven successively into the holes in the work, using the pencil mark as a guide to ensure that all the holes will be opened up to the correct tapping size.

For the Bookshelf

Great Northern Locomotives, 1847-1947, by R. A. H. Weight. 80 pages, size 5¼ in. by 8¾ in., plus art-paper insets. Price 4s. 6d. net. Published by the author, 198, St. Helen's Road, Hastings.

For an author to undertake not only the writing and compilation but the publication of a book which, at the outset, would seem to have a strictly limited appeal, shows an enterprise that is both exemplary and exhilarating. Mr. Weight has accomplished it successfully in this handy little volume, and we think that all enthusiasts who are interested in locomotive history should possess a copy.

The text is commendably light and readable, in spite of the fact that much relevant and essential technical information is included. But Mr. Weight has also recorded some personal narratives which add a great deal to the interest.

The illustrations consist of line drawings interspersed in the text at their appropriate places, while some thirty-four photographs are reproduced on art-paper insets. The frontispiece is a folded plate, one side of which is a reproduction of a photograph of Sturrock's fine 4-2-2 engine No. 215, of 1853, and the other side carries three line drawings with a table of dimensions, comparing principal express passenger engines of, respectively, 1847, 1870 and 1903. The book is obviously the work of an ardent admirer of the old G.N.R. who has made its preparation and publication a labour of love; we would see more of the same kind.

Bogie for the "Maid of Kent"

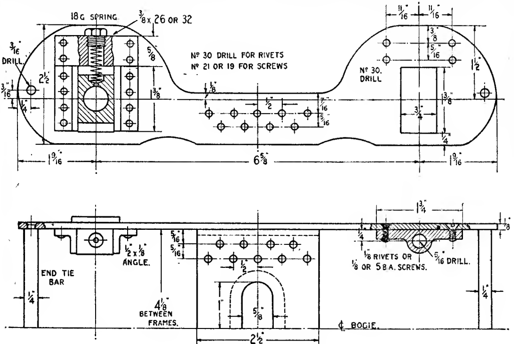
by "L.B.S.C."

YOU will notice that in the leading bogie specified for the "Maid of Kent" I have discarded one of the features found in many engines of this class, to wit, the equalised arrangement of springing. In its place are four simple independent axleboxes, each with an overhead spring. The later Southern engines, such as the "King Arthurs," the "Schools," the "S-15" mixed traffic, and the "Nelsons" have independent springing; so have the L.N.E.R. "Pacifics," the Great Western "Kings," and other engines intended for high-speed work. I have found, on my own little railway, that an independently-sprung bogie holds the road better than an equalised one; and, in passing, might call attention to the fact that independent springing is a modern feature of automobile design. Though it is, of course, arranged for in an entirely different manner to locomotive springing, the object is similar to what we aim for in little engines, viz., smooth running over a rough road. I know of one or two back-garden lines that could lick any portion of the King's Highway for "'umps and 'ollers"—'nuff sed!

As the work of cutting out the bogie frames, attaching horns, milling axleboxes, and turning wheels, is very similar to the jobs on the main frames, etc. only just described, there will be no need to go into full detail all over again, so a brief description, and an "enlargement" on two or three special points, should enable even a raw recruit to knock up a satisfactory leading bogie.

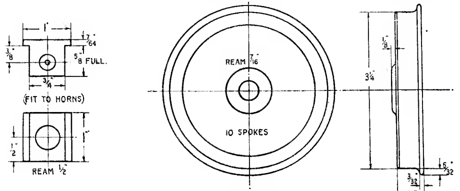
Bogie Frames

Two pieces of $\frac{1}{8}$-in. mild-steel plate are needed, measuring 10 in. by $2\frac{1}{2}$ in. One of these is marked out, same as in the case of the main frame, then the two are riveted together temporarily, and sawn and filed to outline. It will be noticed that the axlebox openings are plain rectangular slots, no horn-stays being provided; this adds to the strength of the frame, and saves work, which is a consideration to those whose spare time is limited, and who desire to get the engine on the road as soon as possible. Note, the $\frac{3}{16}$-in. holes at the ends of the frames are countersunk on the outside. If you are intending to use a built-up bogie centre, drill the holes in the narrow part No. 30; but for a cast centre, drill No. 21 for 5/32-in. screws, or No. 19 for 3-B.A. The holes over the top of the axlebox opening should be countersunk, whether rivets or screws are being used. File off any burrs after parting the plates. You needn't mark them, as the countersinks will indicate the outside.



Bogie for "Maid of Kent"

Castings may be provided for the horn-cheeks, or $1\frac{3}{8}$-in. lengths of $\frac{1}{2}$-in. by $\frac{1}{8}$-in. brass angle may be used. If the former, smooth off the contact faces on a file laid on the bench ; or if you have a milling-machine, put them in the machine vice on the table, and clean up the faces with a cutter not less than $\frac{5}{8}$ in. wide. Then rivet them at each side of the axlebox openings ; if you put a bit of $\frac{3}{4}$-in. bar in the opening, and jam the horn-cheek against it whilst you put a toolmaker's cramp on to hold the horn-cheek in position, the latter must necessarily be in the right place, dead level with the edge of the opening. It is advisable to drill the rivet holes in the horn-cheeks before fitting them, as any burring can then be removed, and the holes form a jig for guiding the drill through the frame-plates. Countersink the holes on the outside of frames ; rivet tightly into the countersinks, and file any projections flush.



Bogie axleboxes and wheels

Castings should also be available for the spring-pockets ; in which case, they only need cleaning up with a file, and drilling and tapping for the spring and cap. Alternatively, they can be sawn and filed from a bit of $\frac{1}{2}$-in. by $\frac{5}{8}$-in. brass bar. Clamp each one temporarily in position, as shown in the illustration, over the tops of the horn-cheeks, and attach by screws or rivets, just as you prefer. I guess even the rawest of recruits, by this time, knows how to use the holes in the frame as a drilling and tapping jig !

How to Erect Frames

The easiest way to do this job is, first, to make and fit the tie bars at each end. Two bits of $\frac{1}{4}$-in. round mild-steel are needed, each approximately $4\frac{5}{8}$ in. long. Chuck in three-jaw, and reduce $\frac{1}{4}$ in. of each end to $\frac{3}{16}$ in. diameter, a tight fit in the $\frac{3}{16}$-in. holes in the ends of the frame plates. Note carefully : the distance between the shoulders must be $4\frac{1}{8}$ in. Put one of the spigots through the hole in the ends of the frame, rivet over and file flush ; ditto the other tie-bar. Then put on the other frame, see that both are square and level by testing on the lathe bed, rivet over the ends of both bars, and file off flush.

Machining a Cast Bogie-bolster

The centre part of the bogie may be either a casting, or built up. If a casting is used, it would be advisable to use a cast bolster as well. To machine this, chuck it by the spigot provided, in the three-jaw, and set the pin at the bottom, to run as truly as possible. If your lathe is a small one, the pin will need supporting by the tailstock centre whilst the bottom of the casting is being faced off, otherwise you risk a dig-in, or chatter-marks over the rubbing surface. Centre the end of the pin with a Slocomb or similar drill in the tailstock chuck, then put the centre-point in, and run up the tailstock so that the centre supports the pin. The bottom of the casting can then be truly faced. For jobs like this, I use a bent tool, with the business end rather pointed and the extreme tip rounded off ; and I don't run the lathe at " Coronation Scot " speed, on account of flying chips, and a bad finish on the work.

When you've a nice faced surface on the casting, reduce the pin to $\frac{5}{8}$ in. diameter ; then further reduce the end for about $\frac{1}{2}$ in., to $\frac{1}{2}$ in. diameter. The junction between pin and bottom of casting can be finished off with a knife-tool set in a little towards the chuck, the length of the pin from shoulder to faced surface being approximately $\frac{15}{16}$ in. Finally screw the end $\frac{1}{2}$ in. by 26 ; if you haven't a die of this pitch, use the nearest available. Shift the tailstock away from the pin, and square-off the end with a light cut or two. The chucking-piece can then be sawn off, and the stump filed flush.

The rebates at the sides of the casting, where it goes between the frames, can be machined out in a manner somewhat similar to the method used for axleboxes. This is easy enough on a milling-machine, or a vertical slide, but a little connivering is necessary when neither is available. About the simplest way would be to take the slide-rest off the saddle and mount the casting on same direct, with a packing-block each side of the bogie pin, and a temporary clamp-bar over the casting, with a bolt at each end to hold it down. The packing-blocks would have to be just the right thickness to allow a $\frac{5}{8}$-in. end-mill, or home-made slot-drill, held in three-jaw, to take the required amount out at one cut. Talking of packing-blocks, a correspondent in the printing trade some years ago sent me an assortment of printers' " furniture," same consisting of die-cast whitemetal blocks of various sizes and

thicknesses, all perfectly true and square in every way; and suggested that they might come in handy for parallel packing on lathe and milling set-ups. They certainly did!

The rebates could also be easily machined on a planer or shaper; or if the casting is clean, ordinary careful hand-filing would suffice. When through, set the casting between the frames in a similar position to the bolster-plate illustrated in the first instalment, and attach by screws through clearing holes in the frame, same as described for a plate bolster.

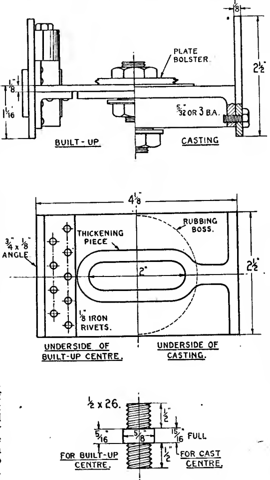
Bogie Centre

For a plate centre, cut a piece of ⅛-in. steel 4⅛ in. long and 2½ in. wide. Cut a slot in the middle 2 in. long and ⅝ in. wide with rounded ends; the easiest way to do this, is to drill a ⅝-in. hole at each end, another in the middle, and file away the metal in between. Make a similar slot in another piece of ⅛-in. steel; cut all around it to a width of ¼ in., so that it looks like an elongated washer, and rivet it over the hole, on the underside of the centre plate, to act as a thickening piece. Rivet two 2½-in. lengths of ¾-in. by ⅛-in. angle along each short side, place the whole issue between the bogie side-frames as indicated in the plan, and attach by rivets or screws as desired. My old friend "Bill Massive" would ornament each frame with nine posh hexagon heads each side, and very nice too, if you have any 5/32-in. or 3-B.A. steel screws with six-sided noddles!

To attach this outfit to the plate bogie-bolster, you'll need a steel bogie-pin, which is merely a bit of ⅝-in. round mild-steel turned down at each end for about ½ in. length to ½ in. diameter, and screwed ½ in. by 26, or whatever other alternative pitch for which you might have a die available. The centre part should be 5/16 in. wide. Poke one of the screwed ends through the hole in the bolster, and put a nut on; a smaller commercial nut, drilled out and tapped to suit, does fine.

Cast centres should be available, and I recommend their use. The sides can be machined off by clamping the casting under the slide-rest tool-holder, and traversing across an end-mill held in chuck. The slot in the middle merely needs cleaning out with a file. On the top, there should be a slight circular projection like a big flat boss standing up about 1/16 in. or so, to make contact with the bolster on the main frame. This can be machined off by chucking the casting in the four-jaw; and the bottom of the casting can be faced off clean, simply by reversing in chuck, and taking a light cut right across it by aid of an ordinary round-nose tool set crosswise in the rest. The casting is then placed between frames, and attached in just the same way as the built-up centre. If a plate bolster has been used, this will require a similar bogie-pin to that mentioned for the plate or built-up centre, except that the pin has a full 15/16 in. of plain part between the shoulders of the screwed ends.

Anybody who has oxy-acetylene equipment, could build up the bogie in two wags of a dog's tail. If I were making it, I should cut the frames out as specified, and erect by the tie-rods; then I should cut out a plate centre, with thickening-piece around the slot, but no angles. This would be jammed between the side-frames in correct position, and secured by a fillet of Sifbronze along the underside, at each side, leaving the top flush. A little Sifbronze would also be run around the thickening-piece. There is a lot to be said in favour of "fabrication," as they have found in full-size practice!



Details of bogie centres

Axleboxes

Either cast or drawn metal can be used, and the *modus operandi* is just the same as described for main axleboxes, so there is no need for repetition. The axleboxes, be it noted, have flanges on one side only, otherwise you couldn't get them in the slots; but this is an advantage with separate springing, as it allows the boxes to tilt freely when the engine runs over a rough road. To locate the countersinks for the ends of the springs, proceed as for drilling the spring-pins in the main boxes; jam each box up tightly against the spring pocket, take off the screwed cap, and poke the drill down the hole, which will

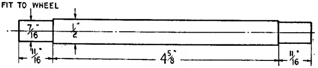
guide it to the correct position on top of the axlebox. A $\frac{1}{16}$-in. hole can be drilled from the bottom of the countersink, into the journal hole, for oiling purposes; see section.

Wheels and Axles

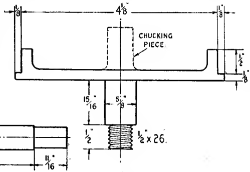
The wheels are "easy meat" after the coupled wheels! For beginners' benefit, here is the job in a nutshell. Chuck wheel truly in three-jaw, holding by tread, back outwards. Face back and boss, and take a roughing cut off flange. Centre, drill 27/64 in. and ream $\frac{7}{16}$ in. Reverse in chuck, face boss and rim, and groove junction of rim and spokes with a parting-tool. Chuck an old wheel casting of similar diameter; face off, recess centre slightly; centre, drill, and tap for $\frac{1}{2}$-in. steel peg. Screw it in, turn down until wheel slides on without shake, then screw the end and fit a nut. Place each wheel on peg, secure it with nut, and finish-turn as described for coupled wheels.

The axles can be turned as described for coupled axles. Press one wheel on each axle. Put each pair of axleboxes in their respective slots, put an axle through them, and press on the other wheel. Take out the screwed plugs in the tops of the spring-pockets; and in each one, put in a spring wound up from 18-gauge tinned steel wire, made as described for coupled axlebox springs. A little piece of $\frac{3}{16}$-in. square rod can be jammed under each axlebox, same as the main boxes; then, if the bogie is attached to the bolster on the engine, and the whole issue stood on a level surface, the trailing wheels of the engine also being in a running position, the top of the frames should be quite level. When a washer and nut are placed on the bottom of the bogie-pin, and the nut screwed up tight, the bogie should be quite free to move from side to side.

It will be noticed that I haven't specified any control springs. These are not necessary for ordinary tracks, as the friction between the bolster plate and the bogie centre is sufficient to stop the locomotive from "hunting" or "nosing" on a straight road, and side control springs might cause undue flange friction on a curved road; but side control springs could easily be fitted by drilling $\frac{1}{4}$-in. holes from frame to the slot in a cast bogie centre, putting in a spring, and plugging the end of the hole with a screw, just like the flint is held in your cigarette-lighter, the ends of the springs pressing against a rectangular block in the transverse slot, mounted on a reduced size bogie-pin.

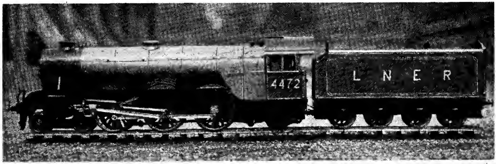


Bogie axle



Cast bogie bolster

A $2\frac{1}{2}$-in. Gauge "Flying Scotsman"



Obviously, the model illustrated is not a really good job, as it is made up from a commercial design; but it may serve to encourage other beginners to take up the game, as it is my first attempt at locomotive building.

I am a great believer in "L.B.S.C.", and when my locomotive was well under way, I did deviate from the plans by fitting a "Petrolea" lubricator.

This engine is a typical S.B. & P.P. job as "L.B.S.C." would call it; but in spite of this it can pull myself and four children with ease.

I should mention that the photograph is by Mr. C. Pratchett.—F. R. Forrest.

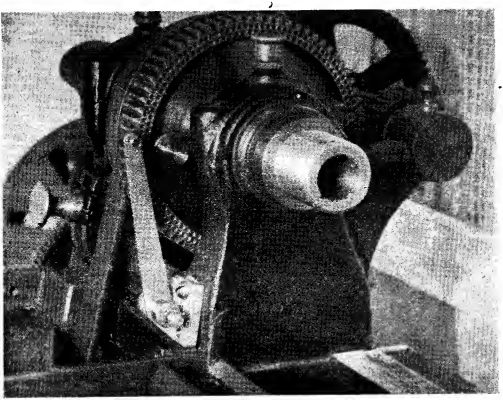
A Simple Dividing Gear

by K. N. Harris

ON my Spencer lathe, which was fully described in THE MODEL ENGINEER, Volume 94, the large back gear wheel on the mandrel was divided into 120, and I replaced the original plain stop pointer with a micrometer-adjusted device to enable divisions other than direct divisors of 120 to be obtained.

The interpolation part of the outfit was not headstock, and due to the unusual arrangement of the back gear in the former, it would not be easy to arrange anything simple.

The Adams-Pittler, however, has the standard type of open back-gear, and, as luck will have it, the large gear on the mandrel has a fairly wide rim face below the bottoms of the teeth, quite sufficient for two rows of holes.



Showing main gear divided with two rows of holes, 100 and 120, and stop fitted

used very much, chiefly for indexing purposes for indicators requiring 25 divisions; but the ability, at a moment's notice, to be able to utilise the spindle for plain dividing was most valuable.

I have now disposed of this lathe, not because it was not a satisfactory tool or because I did not like it; it was a splendid tool and I was very fond of it, but I have a 90-mm. screwcutting Boley lathe which is an even better machine, and I have recently acquired a $4\frac{3}{4}$-in. gap-bed Adams-Pittler, so that the Spencer was quite definitely redundant, and as space is at a premium, it had to go.

Neither the Boley nor the Adams-Pittler has any form of dividing apparatus incorporated in the

It was therefore decided to drill two rings of holes, one to have 120 and the other 100; this is for simple dividing, about as useful a combination as can be obtained, as it covers 120-100-60-50-40-30-25-24-20-15-12-10-8-6-5-4-3-2. As the gear itself has 72 teeth, this number of divisions, together with 36, 18 and 9, can, if necessary, be taken care of also.

The method adopted for dividing was to mount the wheel, outer face up, on the rotary table, using a dummy mandrel accurately to centre it.

In turn, the rotary table was mounted on the drilling-machine table and adjusted until the

(*Continued on page* 128)

*Swords into Ploughshares

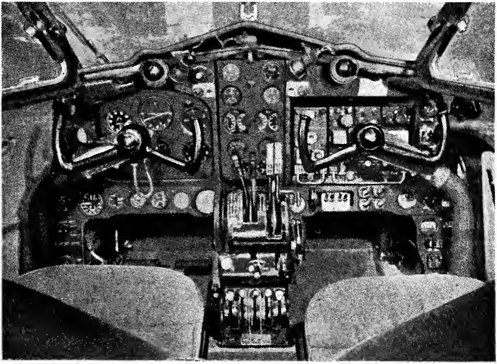
Hints on the adaptation of "surplus" war material for model engineering or utility purposes

Notes on Aircraft Instruments

by "Artificer"

SEVERAL readers have asked for information on the many types of aircraft instruments which are available at the present time, particularly in respect of their adaptation, with or without alteration, to model engineering requirements. To the uninitiated, the array of instruments on the control panel of a modern aircraft is quite awe-inspiring and bewildering, and as the working principles, and even the purpose, of some of these instruments may be abscure to many readers, no apology should be necessary for giving a general review of the subject. The many readers who have served in the R.A.F. or other flying services will find this all very elementary, but if they will bear with the writer for a while, it is not impossible that even they may find one or two useful ideas in this discourse.

The number and diversity of aircraft instruments have been steadily increasing in recent years, and every new improvement or development in aeronautical science has added to the list; but many of the instruments function on the same basic principles, and differ only in terms of calibration, working range, and methods of application. As far as possible, therefore, they will be described and classified in relation to their common features.



View of instruments in the de Haviland "Dove"

Measurements of Pressure

Perhaps the majority of instruments used in aircraft are pressure gauges of some form or other, though not all are calibrated in the orthodox engineering standard of pounds per square inch, or even necessarily in terms of actual pressure as commonly understood. For high or moderate pressures, the familiar Bourdon tube type of instrument is very largely employed, and the operation of this calls for no explanation to readers of this journal, but it may be mentioned

*Continued from page 21, "M.E.," January 1, 1948.

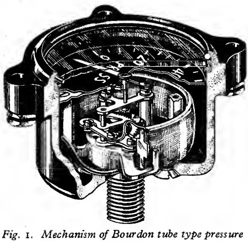


Fig. 1. Mechanism of Bourdon tube type pressure gauge

that there are many variations in the shape and arrangement of such pressure gauges, other than the conventional type illustrated in Fig. 1. Any of these instruments may be applied without alteration, to measurements of air, hydraulic or steam pressure within their appropriate range, provided that in the latter case the instrument is protected from high temperature effects by the usual condensation loop in the supply pipe, or as it is commonly termed, the "syphon tube." A fairly typical example of a pressure gauge used on aircraft is that used on the forced lubrication system of the engine, usually reading up to about 100 lb. per

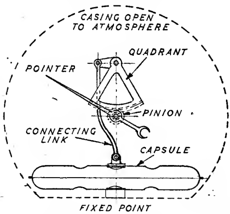


Fig. 2. Diagram illustrating principle of aneroid type of altimeter

sq. in.; other gauges used on hydraulic apparatus, such as undercarriage retracting gear, may read much higher pressures, up to 100 atmospheres, or approximately 1,500 lb. per sq. in.

The Bourdon tube movement is also used in the recording end of certain types of thermometers, as will be described later.

Sensitive Pressure Gauges

It is often necessary to measure extremely small pressures, or more correctly pressure differences, which is usually done by instruments of the diaphragm type, resembling the early type of Schaffer and Budenberg pressure gauge, or by utilising the principle of the aneroid barometer. The simplest of all sensitive pressure gauges, the U-tube manometer, has been used on aircraft with some success, but there are obvious disadvantages in using instruments containing loose liquid in a craft so universally mobile as an aeroplane, and it is now usual to confine the use of liquids to instruments which can be completely sealed, such as levels of various kinds, bank and trim indicators, and bubble sextants. U-tubes are, however, very extensively used for ground testing and calibration of sensitive instruments, as they offer a very convenient and infallible means of applying an exact standard of com-

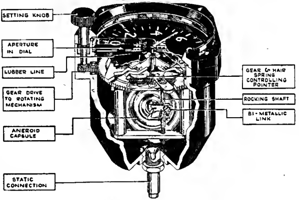


Fig. 3. Modern altimeter of the "rotating mechanism" type

parison. High or moderate pressure gauges are tested by comparison with a piston of a definite area carrying a dead weight, as in normal engineering practice.

The aneroid barometer principle is particularly applicable to use as a sensitive pressure gauge, because it offers a means of absolute, as distinct from merely comparative, pressure measurement. In gauges of the Bourdon tube or single diaphragm types, the reading represents the difference between the inside and outside of the tube, or the two sides of the diaphragm. For pressures above a few pounds per sq. in., this is sufficiently accurate for practical purposes, as the atmospheric pressure variation is not great enough to affect the reading; but in sensitive low-pressure gauges, it would introduce serious errors, and it is necessary to take precautions to avoid these in certain cases.

The aneroid barometer is fairly well understood by most people, but it may be worth while to describe it briefly. Its essential feature is the use of a hermetically sealed elastic chamber, or "capsule," as it is commonly termed, from which

the air has been exhausted before sealing (or at least as far as is practically possible) and thus is is not subject to variations of internal pressure. Any variations in the external pressure, however, cause deflections in the walls of the capsule, which are communicated, by suitable multiplying levers and gearing, to the pointer of the instrument, the dial of which is calibrated in inches of mercury, to conform to the standard type of liquid barometer, in cases where it is used for the original purpose of measuring air density. (Fig. 2.)

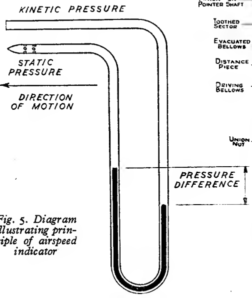


Fig. 5. Diagram illustrating principle of airspeed indicator

The Altimeter

No alterations whatever in the movement of the aneroid barometer are necessary to convert it into a simple form of altimeter; the dial simply needs to be recalibrated to conform with the variation in atmospheric pressure, corresponding to height above sea level. It is, however, usual to provide some form of calibration adjustment, and frequently a temperature compensating device as well; the usual form of the latter is the familiar "bimetal strip," which utilises the principle of differential expansion of two dissimilar metals to cause bending in one of the links or levers of the dial movement and thereby correct errors due to thermal effects. A similar device is used in many other types of aircraft instruments.

Altimeters are often re-converted to use as barometers for domestic and similar purposes. After the first world war, the simple altimeters employed in aircraft of that period were often re-calibrated and suitably mounted—often in the hub-boss of a walnut or mahogany airscrew—and in this form, with or without further embellishment, they provided a useful and more or less tasteful addition to the household gods of the ex-airman or his friends. The modern altimeter is a much more elaborate instrument, as shown in Fig. 3, which represents the "Rotating Mechanism" type, giving four revolutions of the dial in covering the full range of the instrument, which may read up to 40,000 ft. altitude. Other types may embody maximum

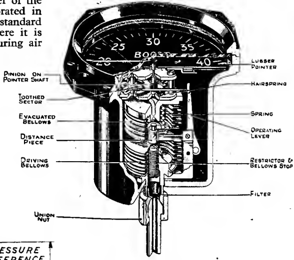


Fig. 4. Boost pressure gauge

height recording gear. But in all cases, the same basic principles are embodied, and conversion to simpler purposes can be carried out in a similar way, with the further elimination of unwanted parts if desired.

Boost Pressure Gauges

While many boost pressure gauges are of the single or compound diaphragm type, measuring the difference between the atmospheric pressure and that in the engine intake manifold, some of them are of the aneroid type, and measure absolute intake pressure (Fig. 4). It may be explained that this gauge, unknown a few years ago, is necessary, or at least desirable, because of the almost universal application of "boost," or supercharge, to aircraft engines. The principal

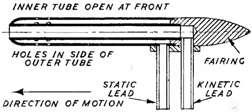


Fig. 6. Concentric tube type of Pitot head

object of this is to counteract the falling-off of power at high altitudes, due to the reduction of atmospheric pressure; but the supercharge is also useful in assisting the take-off of the machine, when it is termed "ground boost," though in many cases it must be used with

discretion, and pressure limiting devices are sometimes fitted.

In some cases the boost pressure gauge is used to operate a carburettor balancing or altitude adjustment, and in cases where fuel injection is employed, it may be used, through servo or relay gear, to adjust the stroke of the injection pumps. When an engine is running without boost, as in a normal "aspirated" or non-supercharged engine, the intake manifold pressure will be well below that of the atmosphere, and thus boost pressure gauges must be calibrated to read both above and below atmospheric pressure, the range being usually from -4 to $+8$ lb. per sq. in., or from 10 in. to 90 in. head of mercury. Such gauges can obviously be used without alteration to measure air pressure in ventilating systems, low-pressure fans and blowers, and exhausters.

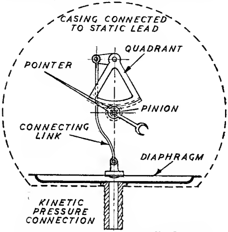


Fig. 7. Diagram of sensitive diaphragm gauge movement as in airspeed and rate of climb indicators

Airspeed Indicators

These instruments are essentially sensitive differential pressure gauges, and apart from the primitive early instruments, such as a lightly-weighted horizontal vane, or even a mere strip of ribbon, have always been of the simple diaphragm type. They work in conjunction with a pressure sampling device known as a Pitot head, the principle of which is well known to all students of aero-dynamics, but will bear a brief description here.

The Pitot head consists essentially of a pair of tubes which are carried outside the aircraft, and point forward in the direction of motion; one of the tubes is open at the front and the other is closed in front but has apertures at the side, as shown in Fig. 5. In the first case, the tube encounters the impact or kinetic pressure of air due to the speed of the craft, but the second tube is protected from impact pressure and only receives the static pressure of the air. Thus the difference in air pressure in the two tubes can be translated in terms of airspeed, and recorded by any suitable sensitive gauge such as the simple U-tube shown in Fig. 5.

In modern practice, the two tubes constituting the Pitot head are usually arranged concentrically as in Fig. 6, where the "kinetic" tube is situated inside the "static" tube, but the separate tube type has been extensively used in the past, and its elimination has only been due to the need to cut down the air resistance of external fittings on aircraft. In either case, the Pitot head is connected by two tubes to the instrument in the cockpit of the machine, the principle of which is illustrated in Fig. 7. It is usual to provide a sealed casing for this instrument, and connect the casing to the "static" lead, the connection from the underside of the diaphragm being taken to the "kinetic" lead. Deflections of the diaphragm are communicated by the connecting link to the rack quadrant and thence to the pinion on the pointer arbor.

The early forms of these instruments had oiled silk or rubber diaphragms, which were highly sensitive, but subject to variation of tension through climatic changes or ageing. Nowadays, more consistent accuracy, and greater robustness to withstand much greater airspeeds, are obtained by the use of very thin flexible metal diaphragms, which are often made double, or practically in the form of an enclosed chamber, to increase sensitivity; but they differ from an aneroid "capsule," not being exhausted of air. Instead, the internal space communicates with either the kinetic or static pressure lead, usually through a capillary tube to give steady reading, as in the instrument illustrated in Fig. 8; the other lead, in either case, being taken to the casing, according to whether the instrument is designed to work by expansion or contraction of the capsule.

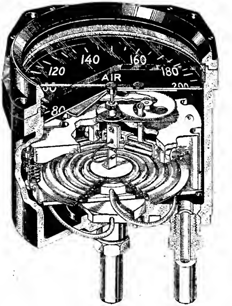


Fig. 8. Modern airspeed indicator

An instrument of this type could be used without its Pitot head as a very sensitive pressure

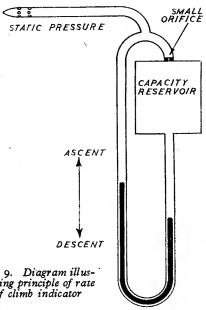


Fig. 9. Diagram illustrating principle of rate of climb indicator

gauge for any desired purpose; in conjunction with the latter, it is a very useful item of equipment for model aircraft research, particularly in connection with a wind tunnel or airscrew test bench; it could also be employed as a high-speed anemometer, but would need recalibration to read at speeds much lower than those usual in modern aircraft.

Rate of Climb Indicators

Very similar principles are employed to measure the rate of climb in aircraft, but in this case only the "static" tube of the Pitot head is employed, and communicates with *both* sides of the diaphragm. Interposed in one of the leads, however, is a capacity reservoir, the inlet to which is through a restricted orifice, as shown in Fig. 9. The effect of this is that the pressure in the reservoir can only change slowly, in comparison with that of the other lead, which is quite open; and the result is that when the aircraft is moving through a varying density of air, as when climbing rapidly, the instrument is temporarily subjected to a difference of pressure and the two sides of the diaphragm are unbalanced. These instruments read both above and below the neutral position, to indicate rates of both ascent and descent, and with suitable recalibration, may be used as combined pressure and depression gauges for very delicate measurements, or for measuring rate of pressure change.

The photograph and cutaway views of instruments are reproduced by courtesy of Smith's Aircraft Instruments Ltd.

(To be continued)

Exhibition of Inventions

The Exhibition of Inventions was held in the Birmingham Chamber of Commerce in December. The exhibition was sponsored by the Birmingham branch of the Society of Inventors. The following brief description of some of the exhibits has been submitted by a correspondent.

A tiny, spring-driven, motor-car chassis, with variable, automatic, steering motion. A rotating cam, driven by a reduction gear from the mechanism, is used to operate proper "Ackerman" steering. The cam, being adjustable, enables almost any evolution to be carried out in a most realistic manner.

A blow-lamp, needing only flexible connections to gas and *water* supplies. Heat from the flame flashes the water into steam, which is used to "pep up the calories" in a similar manner to the normal compressed air supply.

A truly universal bench vice, the "Awlsize," the fixed jaw of which carries a multi-grooved disc upon it, enabling any shape of work to be firmly held. This vice has several other good features, built-in "clam," off-set operation enabling long work-pieces to be held vertically and centrally, and is made in three sizes. It should have a special appeal to our readers.

A swinging-jaw wood-worker's vice, enabling one to grip securely any tapered or odd-shaped work. In this case the moving jaw itself is pivoted in such a way that it takes up the correct position to grip whatever shape is offered to it.

A paint spraying apparatus with a fan providing the air supply, which blows the paint from a moving belt on to the objective. Guard vanes restrict the output to the desired spot, and deflect any excess back to the sump. This would appear to be most useful where a large number of small objects had all to be painted one colour.

Other interesting exhibits included:—

A controlled-heat electric soldering iron, with exact temperature regulation and indication. A paraffin "gas" poker. Neat wire handles for attachment to saucepans, etc., which have "lost" their original ones. An all-insulated electric terminal connector, giving neat and shock-proof connections.

Last, but not least, a device for turning metal rods on drilling machines. So far as could be seen this consisted of a circular metal base, not unlike a drill stand, having graduated holes up to about half-an-inch diameter, any of which can be brought centrally under the drill spindle. The holes thus form a fixed steady for the selected rod size, which is operated on by a radially mounted tool in an adjustable holder. Only a substitute for a lathe, of course, but quite a good one within its obvious limits.

Some of the exhibits are not yet on the market. Many were shown solely with the idea of interesting prospective manufacturers, but there is no doubt that the genial local Hon. Sec. would pass on any request for further details from anyone interested. He is Mr. B. Thornton Clark, of 244, Stoney Lane, Yardley, Birmingham, 25.

A Simple Dividing Gear

(*Continued from page 122*)

centre of the drill spindle was in the required position, relative to the centre of the rotary table.

A Slocomb drill of suitable size was mounted in the drill chuck, and the depth stop adjusted to allow of a very slight countersink, about 1/32 in., of each hole. Naturally, the 120 ring was the outer one. The rotary table is so geared that it revolves through 6 deg. for one turn of the worm; the thimble on the worm spindle is divided into 36, therefore each single division on this thimble represents 10 min. of arc. 120 divisions represent 3 deg. of arc spacing each, therefore in this case half a turn of the worm or 18 divisions of its thimble. Using the hand as a brake, the table was rotated a couple of turns of the worm and locked, the thimble was adjusted and locked, too, the index mark being noted, and the first hole drilled, table unlocked, hand used as brake, worm rotated 18 divisions, table locked and the next hole drilled; repeat 118 times more!

The object of using the hand as a brake is to make certain of taking up any possible backlash, always in the same direction, actually probably gilding the lily. The object obviously of locking the table each time is to prevent any possible movement under the action of the drill. Exactly the same procedure was followed with the inner ring of holes, but here, of course, there had to be a different adjustment of the worm spindle each time. Here we required 3.6 deg. movement between holes = 3 deg. − 36 min.

Therefore, as each division on the thimble = 10 min. of arc movement of the table, the exact division could not be obtained by direct reading. One turn of the worm = 360 min. rotation of the table; we require 216 min. rotation of the table for each 100 divisions, there being 21,600 min. in a circle. Therefore, we must turn our worm $\frac{216}{360}$ of a turn, or three-fifths of a turn.

To accomplish this simply, the handwheel rim of the worm shaft was accurately divided into 5 and used as an index with an improvised pointer, the procedure otherwise being exactly as for the outer ring, three divisions movement being made each time.

The stop was made adjustable for either row of holes. It would, of course, be a comparatively simple matter to make a micrometrically adjustable interpolating stop, but it is really not worth while in my case, as I have separate compound dividing apparatus available.

It is, of course, important that the stop should be rigid and free from any slack in the joints.

For use with a filing rest, a most valuable accessory to any lathe, the divisions required in at least 95 per cent. of cases are either 4 or 6; to expedite the actual handling of the device under such conditions, the outer row of holes have a spot of light blue paint round each twentieth hole (six divisions in all) and the inner row a spot of red paint round each twenty-fifth hole (four divisions in all). This may sound elementary, but it is a real practical time saver, and it does reduce liability to error.

Editor's Correspondence

Curved Cranks

DEAR SIR,—I have noted the correspondence on the subject of curved crank arms. Probably the correct explanation is that given in the following excerpt from David Craik's *American Millwright and Miller.* Writing on cranks in general he says:

"Another delusion is very common with regard to the crank, which is, that by making the iron arm of the crank considerably longer than the intended length of the stroke, and then crook it up in the form of a half-circle or letter S, a great advantage in power is gained. We remember hearing this point argued, when very young, in connection with the cranks used for hand-mills for grinding coffee and spices. But in the year 1836, while employed with the engineers in laying out the works for the renewal of Fort Miffin on the Delaware River, a very amusing controversy occurred on the subject. The moats or canals around the fort had to be pumped dry, and the screw-pumps used for that purpose were worked by six or eight men each. A bevel wheel on an inclined pump, geared into another on a horizontal shaft, fixed across a supporting frame: this shaft had a crank upon each end, each crank being worked by three or four men. The cranks were of wrought iron, and made to get the full benefit of this advantageous leverage; whether from the simple conviction of the maker or to humour the popular prejudice is not material—but the cranks were continually breaking and causing interruptions; and as there was no heavier iron on the works, nor nearer than Philadelphia, the question arose, whether the arm of the crank might not be shortened one-half by making it straight from the shaft to the handle. It was admitted that if this were done the same iron would be strong enough to hold the men, as only four could get hold of the handle at the same time; but some argued that the handles would have to be lengthened to allow more men to get hold before they could work the pump,

and then the crank would break as before ; and these could not be convinced until they saw the straight crank applied, and the pump worked by the same hands and with same ease as before."

The bent cranks used for tread powers, such as those driving turning-lathes, grindstones, or the old-fashioned spinning-wheel by the foot, are instances of the prevalence of the chimera of lengthening the lever, and at the same time maintaining a short range of stroke.

Yours faithfully,
Cranbrook. JOHN RUSSELL.

Negative Lead

DEAR SIR,—In your issue of July 24th, "L.B.S.C." has referred to "negative lead" as "*tommy-rot, an ancient shibboleth and a fallacy*."

That great C.M.E., the late G. J. Churchward, evidently thought otherwise, and if "L.B.S.C." were to ask any G.W.R. engineman he would learn something regarding the performance and method of working a long-travel Stephenson valve-gear as designed and set by that great authority. The negative lead has no virtue in itself as negative lead, *but* it has very great virtue in that it is necessary in order to prevent excessive lead and compression when the gear is notched up.

A Stephenson gear of this sort is as different from a Walschaerts gear as chalk and cheese when it comes to the method of handling it. A negative lead with Walschaerts gear is impossible, as with constant lead it would be a negative lead in all positions of the lever.

"L.B.S.C." mentions the work of the S.R. "N" class 2-6-0. These engines, as well as Stanier 2-8-0s, British Austerity 2-8-0s and Yankee 2-8-0s, worked over the G.W.R. road between Exeter and Plymouth during the war regularly. Any G.W.R. driver will bear me out that a G.W.R. "4300" class 2-6-0 would beat an S.R. "N" to a frazzle for performance, especially in the long, hard banks encountered between Newton and Plymouth, and a little "4300" will do the work done by the West Country class with no fuss and on less coal on either the G.W.R. or S.R. line.

Regarding the 2-8-0s, the "2800" and "3800" classes beat any 2-8-0 that has yet been tried on this section. Why? The "4300's" boiler is smaller than the "N's" and her superheat is much lower.

The higher superheat of the "N's," "Staniers," "Yankees" and "British Austerity" engines should balance the extra cylinder volume of the G.W.R. locomotives.

It is the valve setting and method of working the G.W.R. engines when pulling hard and climbing which gives them their superior performance. At low speeds an engine working without lead is bound to have the better of one with lead, because one is pulling its load and the other has not only the load but the drag of its own lead steam to contend with four times in every revolution.

What Mr. Churchward provided was as near perfection as has yet been achieved, *viz.* a gear which could be notched up to 22 per cent. when running fast and dropped to 45 per cent. when pulling hard, in which position the lead is nil or negligible, and a wonderful help it is to the driver.

I have never known anyone state in THE MODEL ENGINEER that an engine with lead in full gear is of necessity a bad starter, even if Stephenson gear is used provided the lead is not too great, but to set Churchward's gear to a lead in full gear would destroy its principle and court disaster by giving an excessive lead when notched up. In miniature locomotives both Mr. Gill Knight's 0-6-0 Kirtley and my G.W.R. 0-6-0 Armstrong have no lead—mine has 1/64 in. negative lead.

Both engines jump at their load as the regulator is opened, run notched up to 22 per cent. with a full load or ½ to 2/3 regulator at the highest safe speed, are light on coal and water, steam well, and are lovely to handle.

Yours faithfully,
Newton Abbot. A. J. MAXWELL.

Locomotive Brake Blocks

DEAR SIR,—I was very interested to read "Exile's" letter in the January 8th issue. His method of making brake blocks is exactly the same as the one used, ten years ago, for forming similar blocks for my 7-mm. scale L.B. & S.C.R. Stroudley single-wheeler, *Plumpton*.

In my case, however, two rings had to be made, because blocks were required to suit the engine's driving-wheels and the (smaller) tender-wheels. The rings were bored out to 76-mm. and 32-mm. diameter, respectively, and the slots for the hangers were only 1-mm. wide and 2-mm. deep.

Until I saw "Exile's" letter, I had not heard of this method being applied elsewhere.

Yours faithfully,
London, W.C.2. J. N. MASKELYNE.

Hot-air Engines

DEAR SIR,—Referring to the excellent and informative article upon hot air engines in the issue of THE MODEL ENGINEER dated December 18th, 1947, in which were made various suggestions for their improvement.

I agree that it would be definitely advantageous if the displacer piston was made in two separate parts with a good heat insulator between them.

With reference to the intermittent or differential movement of the displacer piston, may I suggest that this could be effected by driving same through elliptical gear wheels or by reciprocating slotted links wherein the slots would have to be so shaped as to give the desired motion to the displacer. What does our contributor think of these ideas?

I wish to add that the elliptical gear wheel drive is not my idea but an application of same which I came across about 1912 in the magneto drive of a Vee twin Swiss-made Moto-Reve motor-cycle engine of about 2 h.p. with cylinders set at 45 deg. The drive ensured the magneto giving its maximum spark efficiency at the correct firing time for each cylinder. The elliptical gear wheels furnish a method whereby a variable rate of reciprocation can be achieved in a fairly easy and economical manner. I have no doubt that there are certain snags which would crop up in the making of the wheels, but these are easily surmountable.

Yours faithfully,
Mansfield. J. B. S. POYSER.